SCIENTIFIC NOTATION AND SIGNIFICANT FIGURES WORKSHEET

SCIENTIFIC NOTATION

A digit followed by a decimal and all remaining significant figures and a power of 10 is in scientific notation.

Q1. Consider the following values.

6.7 x 10^2	36 x 10^4	π x 10^7	2 x $10^{7.61}$	4 x 10^{36}	7.61 x 10^0
0.67 x 10^3	382	-5.24 x 10^{-8}	4/3 x 10^5	7 x 10^{π}	5 x $10^{4/3}$

a. In the blank space preceding each value, mark all those that are in correct scientific notation with a check mark and mark those that are incorrect with an X.

b. What are the rules for correctly expressing a value in scientific notation?

Q2. a. Rewrite each value below in scientific notation.

i. 1, 990, 000, 000, 000, 000, 000, 000 kg ii. 0.000 000 000 000 000 000 000 000 911 kg

b. What is the advantage of using scientific notation?

c. Rewrite each value below in scientific notation.

i. The charge of a proton is 0.000 000 000 000 000 16 C.

ii. The mass of earth is 5 980 000 000 000 000 000 000 000 kg

iii. The width of the classroom is 6 m

iv. A charge of 1. 000 000 000 000 000 000 16 C

Q3. SI NOTATION: Complete the following

RAW VALUE	SI Prefix Notation
96 740 m	
500 000 000 Hz	
227 000 000 000 B	
0.000 000 008 s	

Significant Digits

Numbers have meaning. In any science when you record, observe, or calculate using measured values your communicate something regarding the **Precision** and **Accuracy**

Precision is the degree of exactness to which a measured value can be reproduced.

Accuracy is the extent to which a measured value agrees with the standard value of a quantity.

ALL devices have limits to their precision; therefore the number of significant digits needs to reflect this.

- The last digit recorded in any measurement in science is an estimate and is uncertain.
- The last digit is the only uncertain digit in your measurement
  - A good rule of thumb is: “Your precision is limited to a half of the smallest interval”

- Anytime a measurement is recorded, it includes all digits that are certain ***plus*** one uncertain digit.

- These certain digits plus the one uncertain digit are called significant digits.

- The more significant digits in a recorded measurement, the more precise the measurement.

Use the following rules to determine the number of significant digits in a recorded measurement.

1. **Digits other than zeroes are always significant.**
   967 3 significant digits
   96.7 3 significant digits
   9.6 2 significant digits

2. **Zeroes between two other significant digits are always significant.**
   9.067 4 significant digits
   9.007 4 significant digits

3. **Zeroes at the beginning of a number are never significant. They merely indicate the position of the decimal point.**
   0.02 1 significant digits
   0.000262 significant digits
   0.000204 3 significant digits

4. **Zeroes that fall at the end of a number and after the decimal point are always significant.**
   0.200 3 significant digits
   3.0 2 significant digits
   0.200305 significant digits

5. **When a number ends in zeroes, the zeroes are *AMBIGUOUS*. We will treat them as non-significant.(unless there is a decimal point)**
   150 000 000 2 significant digits
   130 2 significant digits
   800. 3 significant digits

Use the following rules to determine how to round off values.

1. **Round down if below 5, up if above 5.**
   0.643 gets rounded to 0.64
   0.469 gets rounded to 0.47

2. **Round up if the digit before the five is odd.**
   0.275 gets rounded to 0.28 because '7' is odd

3. **Round down if the digit before the five is even.**
   0.265 gets rounded to 0.26 because '6' is even

To avoid confusion about the number of significant digits in a measurement, convert the measurement to scientific notation. When this is done, the digits in the decimal part of the number represent the significant digits.

$7600 = 7.6 \times 10^3$ 2 significant digits
$0.000967 = 9.67 \times 10^{-3}$ 3 significant digits
$0.00005810 = 5.810 \times 10^{-5}$ 4 significant digits

Q4. In the following table, write the number of significant digits beside each value

Value	Sig Digs	Value	Sig Digs	Value	Sig Digs
6, 340, 000		12 300		67.1	
713		91 400.0		11.400	
8.14		48 400		2 940	
0.332		6.310×10^4		5 240	
0.000 051		3.95×10^4		8.000 132	
1.21×10^{-4}		52 401		100	

Mathematical Operations with Uncertain Quantities

Multiplication and Division:

The product or quotient(**multiplication** or **division**) has as many significant figures as the least accurate measurement.

8.56 cm x 2.3 cm = 19.688 cm^2 = 20 cm^2

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  6.548
 × 7.32
 .13096
1.96440
45.83600
47.93136
 = 47.9
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Addition and Subtraction:

The sum or difference has as many significant figures after the decimal as the least accurate measurement.

14.65 g + 256.5 g + 0.645 g = 271.795 g = 271.8 g

76.0 m – 56.72 m = 19.28 m = 19.3 m

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 6.548
 + 7.3
13.848
= 13.8
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- If you have problems, which involve both **multiplication/division** *and* **addition/subtraction**, you must keep track of the number of significant digits used in the problem.

Q5. Indicate the number of significant figures for each of the measurements.

37.2 m	56 cm	0.000 076 s	104.080 J
0.80 kg	301.5 kg	789 mm	5.60 x 10^2 m/s^2
56.02 m	4.24 x 10^3 m	5.00 cm	0.050 m
2.999 x 10^6 m/s	9.7 x 10^{-10} m	0.00015 g	

- There are some circumstances where you would not use significant digits
  1. **If you are counting objects.**
     If you have 5 rows of 5 dogs you have 25 dogs, not 3 x 10^1 dogs
  2. **Constants used in an equation are not used in significant digits; they are exact!**
     The equation for the circumference of a circle is $2\pi r$.
     The 2 and the π are not used in determining the number of significant digits.
     The circumference should have the same number as significant digits as the radius.

Q6. Calculate the answer and express the answer to the correct number of significant figures. It is not necessary to use scientific notation.

37.2 + 0.12 + 363.55 =

362.66 – 29.2 =

4005.34 – 325.2600 =

0.00076 – 0.00060000 =

2.4 x 6.0 =

0.23 x 0.350 x 4 =

55 x 0.540 x 326 =

0.0060 x 55.1 x 26 =

750 / 3.1 =

0.094 x 720 / 4.4 =

Significant Digits: Practice and Review

Q7. State the number of significant digits in each of the following.

(a) 809
(b) 5.60
(c) 0.0060
(d) 0.010
(e) 560
(f) 560.
(g) 0.0000095
(h) 5.743
(i) 0.00005
(j) 2.0×10^5

Q8. Express each of the following in scientific notation.

(a) 5808
(b) 0.000 063
(c) 5300 (2 S.F.)
(d) 29 979 280 000 (7 sig. figs)
(e) 0.000 000 000 913
(f) 0.060 30
(g) 30 000 000 000 (1 S.F.)
(h) 0.70
(i) 58
(j) 4

Q9. Express each of the following in common notation.

(a) 6×10^1
(b) 6.2×10^3
(c) 7.4×10^9
(d) 9.1×10^{-2}
(e) 4.367×10^5
(f) 4.3×10^2

Q10. Perform each of the following mathematical operations, expressing the answers to the correct number of significant digits.

(a) 37.2 + 0.12 + 363.55
(b) 362.66 - 29.2
(c) 4005.34 - 325.2600
(d) 0.000 76 - 0.000 600
(e) (2.4)(6.0)
(f) (0.23)(0.35)(4.0)
(g) (55)(0.54)(326)
(h) (0.0060)(55.1)(26)
(i) 750/3.0
(j) 635/8.2
(k) 0.452/0.014
(l) [(6.21)(0.45)]/5.0
(m) [(0.94)(720)]/4.4
(n) 500 + 50
(o) 2.5^2
(p) $4.9^{1/2}$
(q) $3.1^2 + 9.65^{1/2}$
(r) $(2.21^3)(6.4^2)$
(s) 1200 + 3 =
(t) $4.25^{1/2} - 2.1^{1/2}$

Q11. Simplify each of the following, using scientific notation where appropriate.

(a) $10^1 \times 10^1$
(b) $10^3 \times 10^2$
(c) $10^{-1} \times 10^5$
(d) $10^{-5} \times 10^2$
(e) $10^2/10^4$
(f) $10^3/10^7$
(g) $10^{-5}/10^2$
(h) $10^{-5}/10^{-6}$
(i) $(1.3 \times 10^2)(3 \times 10^1)$
(j) $(4 \times 10^6)/(2 \times 10^3)$
(k) $6.3 \times 10^{-2}/3 \times 10^{-4}$

Q12. Express the following using metric prefixes:

(a) 10^6 volts
(b) 10^{-6} meters
(c) 5×10^2 days
(d) 8×10^3 bucks
(e) 3×10^{-9} pieces
(f) 6.67×10^{-11} freaks

Q13. Write the following as full (decimal) numbers with standard units:

(a) 35.6 mm
(b) 25 ns
(c) 250 mg
(d) 565 nm
(e) 3.2×10^{-6} TA
(f) 500 picoseconds
(g) 2.5 femtometers
(h) 25 gigavolts.
(i) 56decagrams

Q14. The speed of light is 3.00×10^8 m/s. How many metres are there in a light-year? (A light year is the distance light travels in one year)

Q15. If the volume of a ping pong ball is approximately 1.0×10^{-4} m^3, how many ping pong balls could you put in an empty science laboratory whose dimensions are 15.2 m, 8.2 m, and 3.1 m?

Q16. What is the area of a circle of radius 2.8×10^4 cm?

Q17. When making calculations in laboratory work, it is important to use the correct number of significant figures to express measured and calculated results. With this in mind, calculate the following:

a. 100 m / 14 s =
b. 3 kg x 6 m/s =
c. 13. 4 m/s x 27.8 s =
d. 10.30 cm / 4.2571 s =
e. 0.24 A x 3.56 V =
f. 2.6 N x 0.43